

## CLAIMS

1. A brushless DC motor driving method comprising:

a brushless DC motor having a stator and a rotor including a permanent magnet,

5 an inverter for supplying electric power to the brushless DC motor,

a drive unit for driving the inverter,

a position detecting unit for outputting rotor position signal based on the voltage induced on the stator of the brushless DC motor,

10 a first waveform generating unit for outputting drive signal based on the rotor position signal, while performing PWM duty control,

a second waveform generating unit for outputting drive signal driving the brushless DC motor as a synchronous motor, while keeping the PWM duty constant, and

15 a commutation judging unit for driving the inverter through the drive unit by selecting one of the drive signal from the first waveform generating unit and the drive signal from the second waveform generating unit,

20 wherein the commutation judging unit selects the drive signal from the first waveform generating unit during low-speed rotation of the brushless DC motor, and selects the drive signal from the second waveform generating unit during high-speed rotation of the brushless DC motor.

2. The brushless DC motor driving method as defined in Claim 1, wherein the first waveform generating unit outputs a drive signal of a rectangular wave or a waveform similar to it with an conductive angle no less than 120° but no more than 150°, and the second waveform generating unit outputs a drive signal of a  
25 rectangular wave or a waveform similar to it with an conductive angle no less than

130° but no more than 180°.

3. The brushless DC motor driving method as defined in Claim 1, wherein the commutation judging unit equalizes, when it switches the selection between the drive signal from the first waveform generating unit and the drive signal from the second waveform generating unit, the output timing of drive signal before and after the switching.

4. The brushless DC motor driving method as defined in Claim 1, wherein the commutation judging unit produces, when it switches the selection between the drive signal from the first waveform generating unit and the drive signal from the second waveform generating unit, a difference in the output timing of drive signal before and after the switching.

5. The brushless DC motor driving method as defined in Claim 1, wherein the commutation judging unit has a function of preventing, when it switches the selection between the drive signal from the first waveform generating unit and the drive signal from the second waveform generating unit, increase of the electric current flowing through the brushless DC motor.

6. The brushless DC motor driving method as defined in Claim 1, wherein the brushless DC motor comprises the rotor having saliency with a construction in which a permanent magnet is embedded in the rotor core.

7. The brushless DC motor driving method as defined in Claim 1, wherein the brushless DC motor drives a compressor.

8. A brushless DC motor driving apparatus, comprising:

a brushless DC motor having a stator and a rotor including a permanent magnet,

an inverter for supplying electric power to the brushless DC motor,

a drive unit for driving the inverter,

a position detecting unit for outputting rotor position signal based on the voltage induced on the stator of the brushless DC motor,

5 a rotating speed detecting unit for detecting the rotating speed of the brushless DC motor from the rotor position signal,

a first waveform generating unit for outputting drive signal based on the rotor position signal, while performing PWM duty control,

10 a second waveform generating unit for outputting drive signal driving the brushless DC motor as a synchronous motor, while keeping the PWM duty constant, and

a commutation judging unit for driving the inverter through the drive unit with drive signal output by the first waveform generating unit during low-speed operation when the rotating speed of the brushless DC motor is under the prescribed rotating speed, but driving the inverter through the drive unit with drive signal output by the  
15 second waveform generating unit during high-speed operation when the rotating speed of the brushless DC motor exceeds the prescribed rotating speed.

9. The brushless DC motor driving apparatus as defined in Claim 8, further comprising a frequency setting unit for setting the frequency of output waveform from the second waveform generating unit, and a frequency limiting unit for  
20 limiting the frequency set by the frequency setting unit so that the frequency of output waveform from the second waveform generating unit may not exceed the upper limit frequency.

10. The brushless DC motor driving apparatus as defined in Claim 9, comprising an upper limit frequency setting unit for setting the upper limit  
25 frequency based on the maximum frequency of the waveform from the first

waveform generating unit.

11. The brushless DC motor driving apparatus as defined in Claim 9, wherein the first waveform generating unit outputs a drive signal of a rectangular wave or a waveform similar to it with a conductive angle no less than  $120^\circ$  but no more than  $150^\circ$ , and the second waveform generating unit outputs a drive signal of a rectangular wave or a waveform similar to it with a conductive angle no less than  $130^\circ$  but no more than  $180^\circ$  at a frequency determined by the frequency setting unit.

12. The brushless DC motor driving apparatus as defined in Claim 10, further comprising an upper limit frequency changing unit for resetting the upper limit frequency, after the brushless DC motor is operated for prescribed time with the drive signal output from the second waveform generating unit.

13. The brushless DC motor driving apparatus as defined in Claim 9, further comprising a voltage detecting unit for detecting the output voltage supplied to the inverter, and an upper limit frequency correcting unit for correcting the upper limit frequency based on the voltage value detected by the voltage detecting unit.

14. The brushless DC motor driving apparatus as defined in Claim 9, further comprising a current detecting unit for detecting the output current of the inverter, and a phase difference detecting unit for changing the upper limit frequency based on the phase of the output voltage of the output current detected by the current detecting unit.

15. The brushless DC motor driving apparatus as defined in Claim 9, further comprising a current detecting unit for detecting the output current of the inverter, and an amplitude detecting unit for changing the upper limit frequency based on the amplitude of the output current detected by the current detecting unit.

16. The brushless DC motor driving apparatus as defined in Claim 8, further

comprising a frequency setting unit for setting the frequency of the drive signal output by the second waveform generating unit, and a frequency commanding unit for instructing the frequency of the rotating speed detected by the rotating speed detecting unit to the frequency setting unit.

5        17. The brushless DC motor driving apparatus as defined in Claim 8, further comprising a frequency setting unit for setting the frequency of the drive signal output by the second waveform generating unit, and an coincidence judging unit for judging if the detecting timing of the rotating speed detecting unit coincides with the output timing of the second waveform generating unit and, if coincidence is  
10 confirmed, instructing the frequency set by the frequency setting unit as output frequency to the first waveform generating unit.

18. The brushless motor driving apparatus as defined in Claim 8, comprising a frequency correcting unit for correcting the frequency of rotating speed detected by the rotating speed detecting unit, and instructing it as output frequency to the  
15 frequency setting unit.

19. The brushless DC motor driving apparatus as defined in Claim 8, comprising a deviation judging unit for judging if the detecting timing of the position detecting circuit remains within the range of tolerance or not against the output timing of the second waveform generating unit and instructing the frequency  
20 set by the frequency setting unit as output frequency to the first waveform generating unit.

20. The brushless DC motor driving apparatus as defined in Claim 8, further comprising a stop detecting unit for detecting if the brushless DC motor is at stop with abnormality or not based on the output signal from the position detecting unit,  
25 and a protective stopping unit for stopping the driving of the inverter by the drive

unit in case the stop detecting unit detected some unusual stop.

21. The brushless DC motor driving apparatus as defined in Claim 20, constructed in a way to restart, after the protective stopping unit stopped the driving of the inverter by the drive unit.

5        22. The brushless DC motor driving apparatus as defined in Claim 8, further comprising an abnormality detecting unit for detecting abnormality in the rotation of the brushless DC motor based on the position detecting timing of the position detecting unit.

10        23. The brushless DC motor driving apparatus as defined in Claim 22, wherein the abnormality detecting unit detects presence of abnormality in the rotation of the brushless DC motor, in case the position detecting timing of the position detecting unit got out of the prescribed range before and after the "ON" timing of the switching elements of the inverter.

15        24. The brushless DC motor driving apparatus as defined in Claim 22, wherein the commutation judging unit switches, while driving the inverter with the second waveform generating unit, the driving with the second waveform generating unit to driving with the first waveform generating unit, in case the abnormality detecting unit detected some abnormality in the rotation of the brushless DC motor.

20        25. The brushless DC motor driving apparatus as defined in Claim 24, wherein the commutation judging unit switches, after switching the driving with the second waveform generating unit to driving with the first waveform generating unit, following detection of abnormality in the driving of the brushless DC motor by the abnormality detecting unit, if nothing unusual is detected with the rotation of the brushless DC motor.

25        26. The brushless DC motor driving apparatus as defined in Claim 8, further

comprising a current detecting unit for detecting the output current of the inverter, an abnormality judging unit for judging the state of motor rotation based on the current detected by the current detecting unit, and a protective stopping unit for stopping the driving of the inverter by the drive unit in case the abnormality judging  
5 unit judged presence of abnormality.

27. The brushless DC motor driving apparatus as defined in Claim 8, wherein the brushless DC motor comprises a rotor having saliency with a construction in which a permanent magnet is embedded in the rotor core.

28. The brushless DC motor driving apparatus as defined in Claim 8, wherein  
10 the brushless DC motor drives a compressor.